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(54) Marine propeller pitch control system

(57) In the relaxed/unstressed condition spring means 26 bias piston 20 towards the outboard end of actuator 17 so that propeller blades 12 which are acted upon via piston rod 21 and yoke 33 take up a fine-pitch angle (low-gear position). When an increase in speed is required, pressure fluid is pumped down channel 30 and acts upon the outboard side of the piston 20 to move the blades 12 to a coarse-pitch angle (high-gear position).

This system is much easier and less expensive to construct and fit then previous systems as no high-precision control shaft is required to extend through propeller hub 11. A further advantage is that the unstressed condition (which would occur if the pressure fluid system failed) results in fine-pitch blade angle, which is the "natural" position taken up by the blades 12.

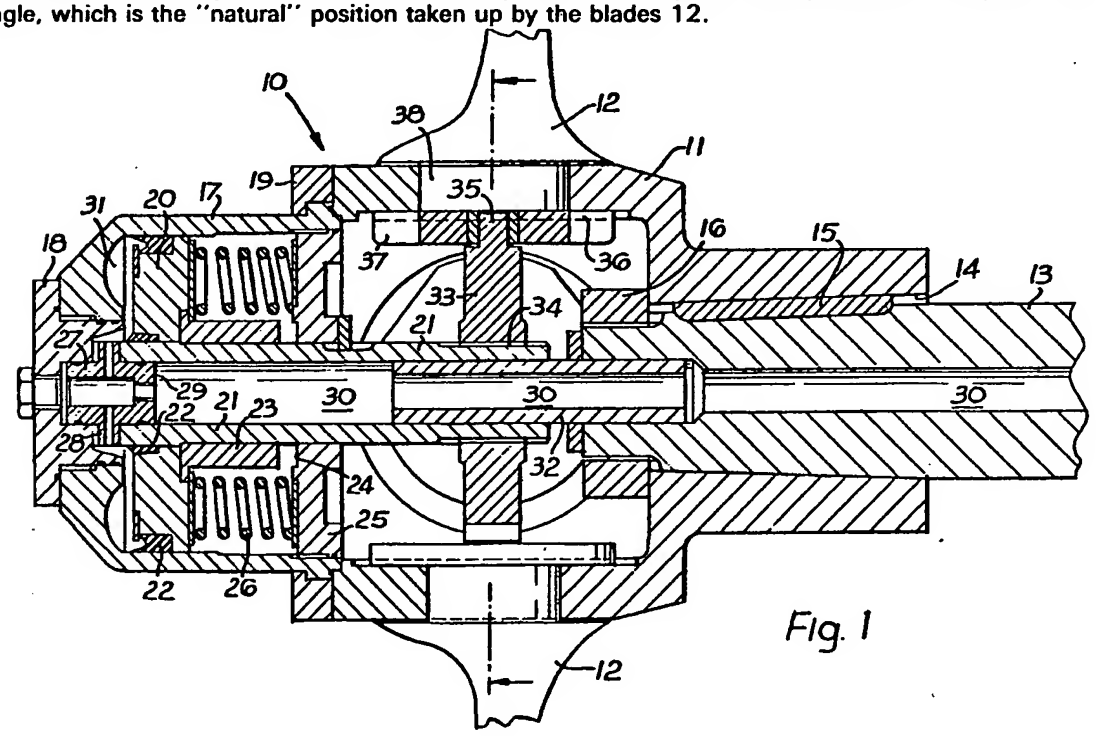

Fig. 1

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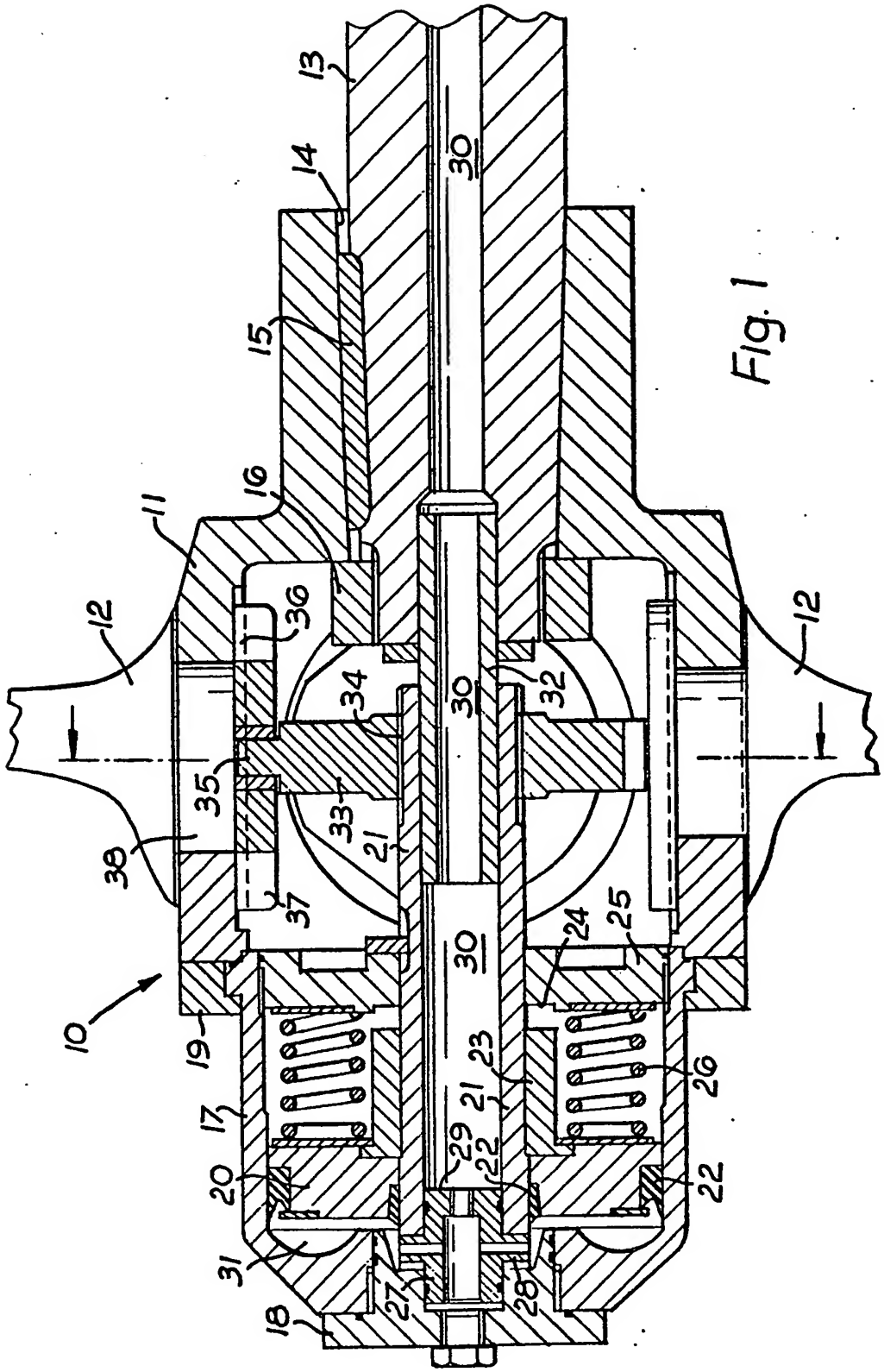
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Fig. 1

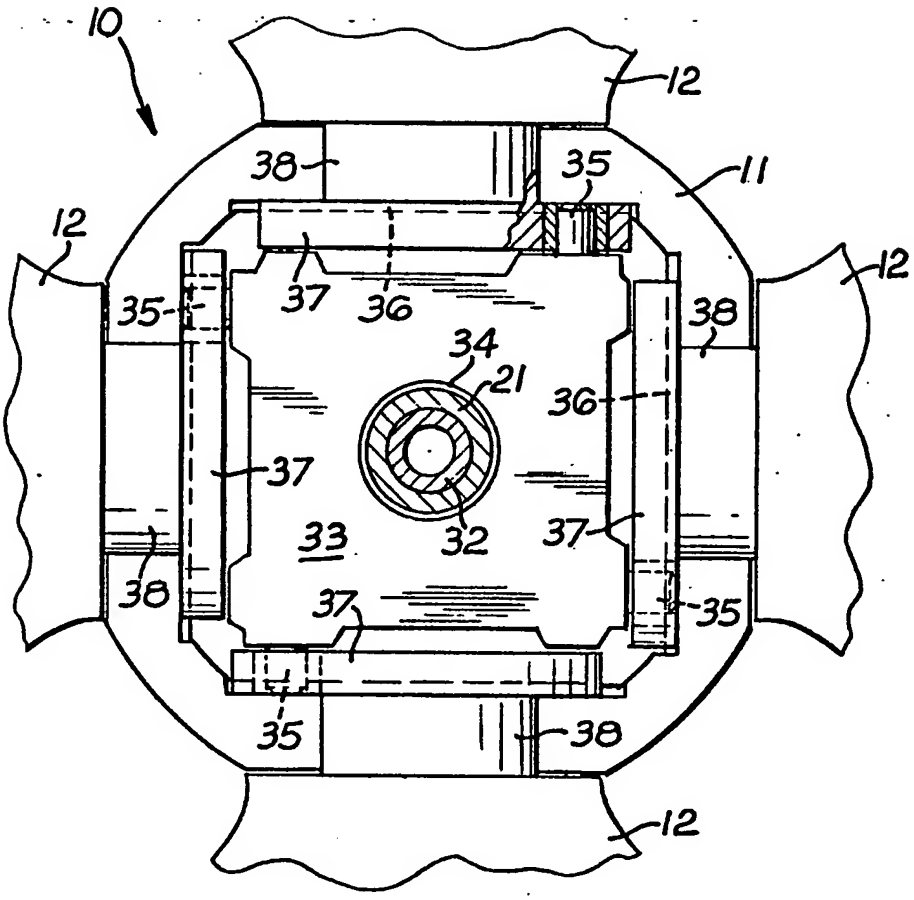

Fig. 2

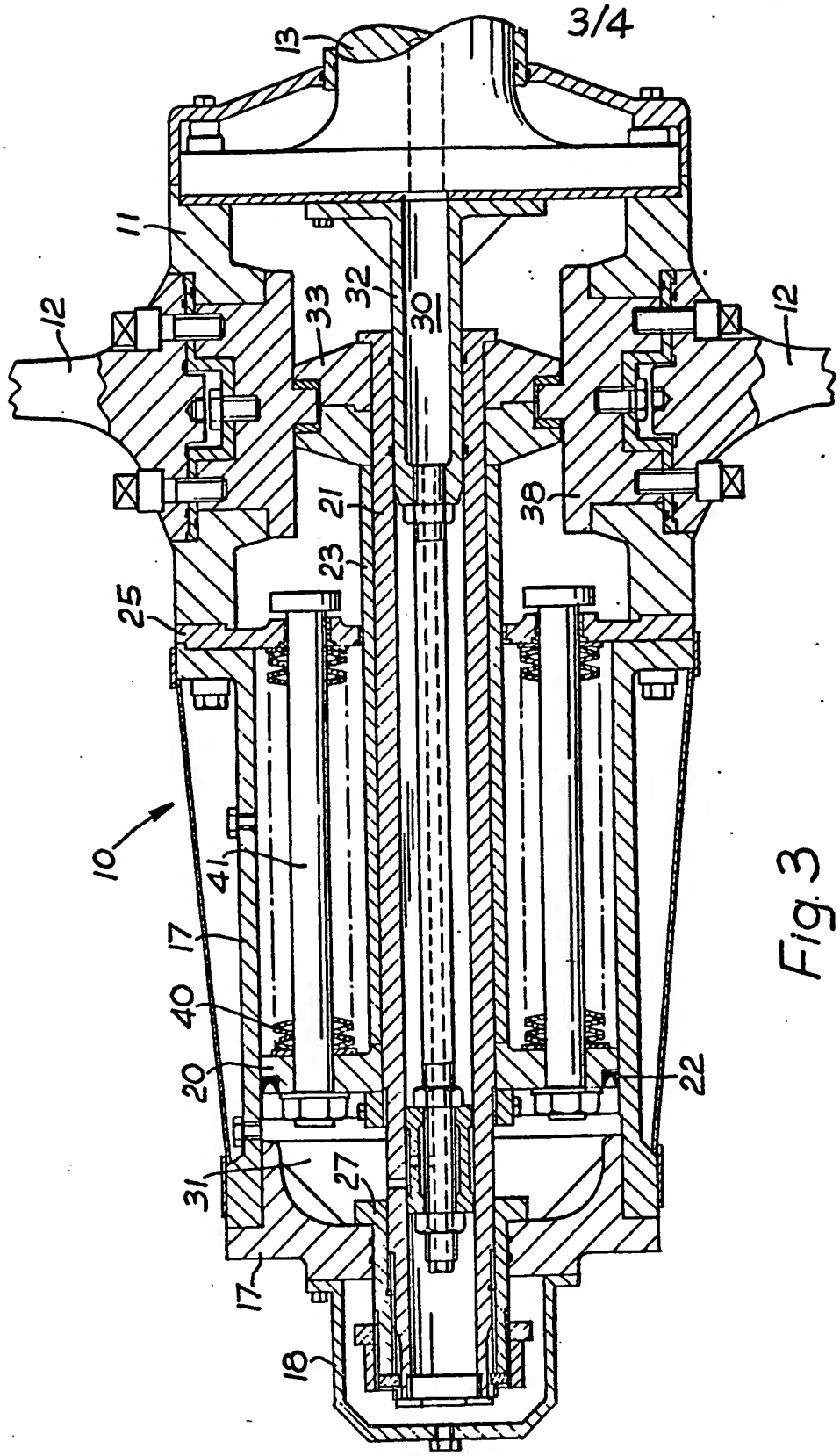

Fig. 3

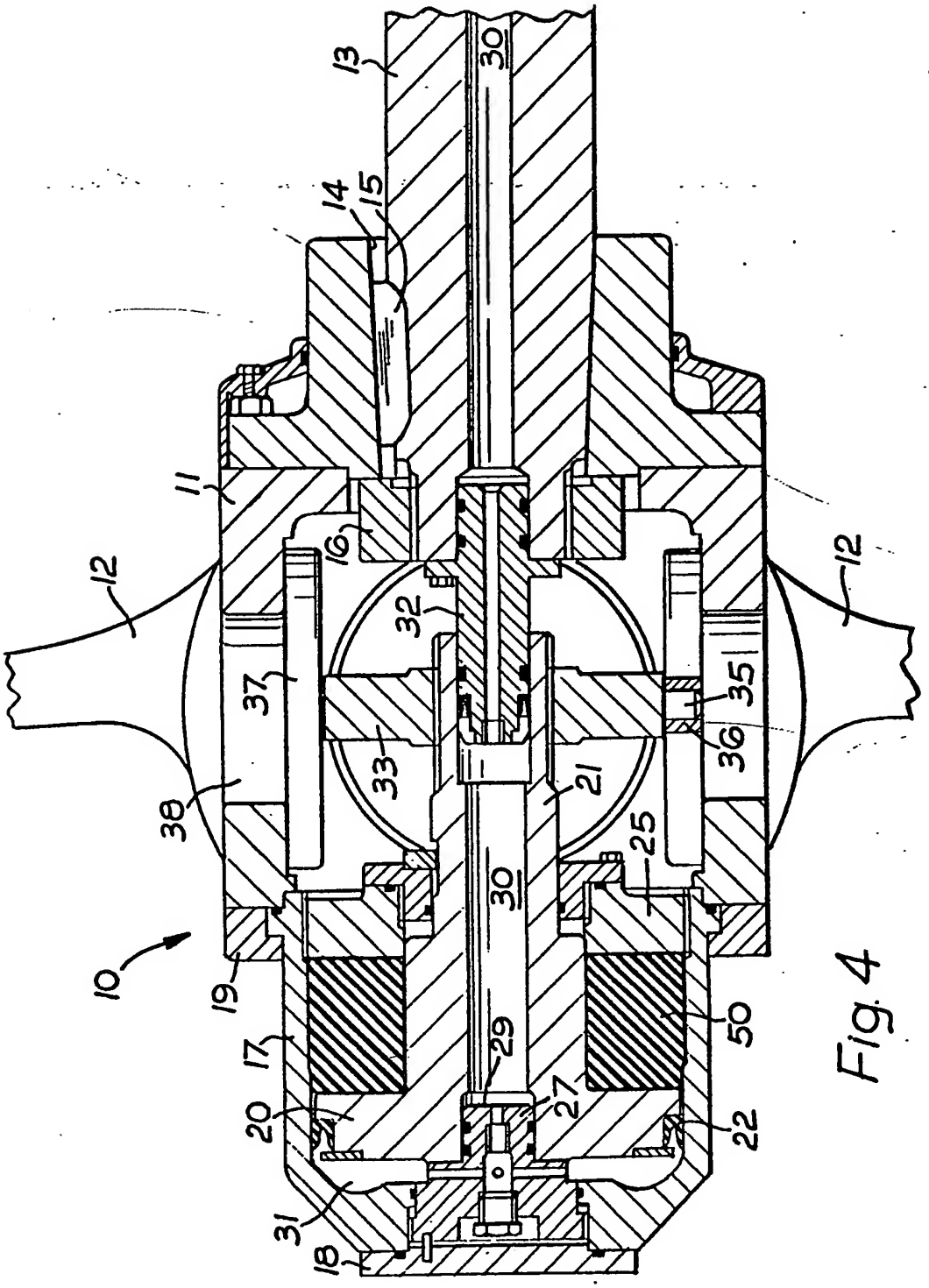
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Fig. 4

SPECIFICATION

Marine propeller pitch control system

This invention relates to a marine propulsion system of the kind which includes a power driven screw propeller having blades of adjustable pitch.

In known system of the kind referred to, such as those described in British Patent Specifications 1510969 and 1510970, marine propeller blades are adjustable between two predetermined limiting settings, namely a coarse-pitch angle and a fine-pitch angle by a conventional pitch control mechanism. This mechanism is actuated by a pitch control rod connected to a fluid pressure operated piston remote from the propeller and usually adjacent a gear box which transmits power from an engine or other prime mover to rotate the propeller.

Such known systems have a number of disadvantages, the main one being that the precision required of the long pitch control rod of the bore in the shaft through which it extends between the piston and the pitch control mechanism and of the various seals and couplings therebetween make the entire system extremely expensive and, moreover, extremely difficult to accurately assemble and install into ships at dockyards. A further difficulty arises in that the system is arranged such that actuation of the piston by fluid (usually oil) to push the rod in the outboard direction towards the propeller results in a fine-pitch propeller blade angle, while release of the piston allowing the rod, which is spring-biassed, to move back in the inboard direction results in a coarse-pitch propeller blade angle. Since a fine-pitch angle, that is to say a blade angle substantially radial to the axis of the propeller hub, occurs naturally when no control is exerted on the propeller blades, the above-mentioned control scheme is, so to speak, the wrong way around. Under that scheme fine-pitch is achieved by positive pressure on the piston, rod and pitch control mechanism, while coarse-pitch is achieved when pressure is released. However, since when released from pressure the blades naturally tend to move towards fine-pitch, they tend to waver when held in coarse-pitch. Moreover, in the event of failure of the fluid pressure supply to the piston, the blades will be held in the coarse-pitch setting which is suitable for higher speed normal running (equivalent to high gear) whereas in most circumstances it would be more favourable if, upon failure, the blades were held in fine-pitch setting which is suitable for towing, trailing and other conditions of increased propulsive thrust and/or lower speeds (equivalent to low gear).

Yet another inconvenient feature of such systems is that the exact fine and coarse pitch settings are determined by the thicknesses of two piston stop rings and so-called "fine tuning" of propeller blade pitch control is dependent on selection and fitting of stop rings of appropriate thickness. Thus after initial trials it may be necessary to partially dismantle the propeller and its actuation system to effect such fine tuning.

An object of the present invention is to provide a marine propeller pitch control system which does not have any of the aforesaid disadvantages.

With this object in view the present invention provides a marine propeller pitch control system comprising a screw propeller having a hub with variable pitch blades whose range of pitch angle variation extends between two predetermined limiting settings namely a fine-pitch angle and a coarse-pitch angle, a shaft connecting the propeller to a gear box and driving motor, and a channel extending through the shaft and into the propeller so that pressure fluid admitted through the channel sets on a piston disposed within the outboard end of the propeller, which piston is operatively coupled to a pitch control mechanism for effecting pitch angle adjustment of the blades, the piston having permanently acted on by spring means biassing the piston towards a first limiting position corresponding to a predetermined fine-pitch angle of the blade, means being provided to selectively admit pressure fluid through the channel to force the piston to move against the biassing action of the spring means towards a second limiting position corresponding to a coarse-pitched angle of the blades.

It will be appreciated that, in contrast to prior proposals, in the pitch control system in accordance with the present invention there is no precisionformed piston rod/switch control rod extending through the propeller shaft from a remote piston-type actuator means to the pitch control mechanism in the body of the propeller. Instead the fluid pressure-operated piston is located within the outboard end of the propeller itself so that the proposed pitch control system is formed as a single compact unit for fitting to the end of a propeller shaft and its transportation and installation is far easier and less prone to inaccuracies than hitherto. Indeed, the hub-actuated arrangement of the present invention enables a fully assembled and tested propeller unit to be transported to a dockyard or other assembly site without any danger of damage in transit and to be fitted in position by relatively unskilled labour. All previously known controllable or multi-pitch systems have had to be assembled and installed on site by highly skilled labour in view of the provision of a precision shafting system.

In the present invention, the channel through the propeller shaft need not, of course, be formed with great precision.

Moreover, during its active stroke the piston is moved from outboard to inboard (i.e. in the opposite direction compared to the prior arrangement) towards a limiting position corresponding to a coarse-pitch angle of the blades, whereas when the fluid pressure is released it is biassed towards the outboard end of the propeller so that the blades take up a fine-pitch angle. Accordingly, the "release" position is the unstressed position naturally taken up by the blades and in the event that the fluid pressure supply means should fail the blades would take up their natural low-speed fine-pitch angle.

Preferably, the propeller incorporates abutment means which serve to restrict the movement of the piston between the aforesaid first and second limiting positions.

The spring means may consist of a stack of disc springs, or, alternatively a number of coil springs or resilient blocks of rubber or similar material.

Advantageously a portion of the channel is formed through a member which threadedly engages a propeller yoke so that fine tuning of the blade pitch settings can be easily effected by manual rotation of the outboard end portion of the propeller with respect to said yoke so as to increase or decrease the tension of the spring means. Fine tuning is, of course, important to achieve maximum efficiency of the propulsion system and in this case it can be readily achieved without the need to partially dismantle the pitch control system.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a fragmentary longitudinal cross-section illustrating a first embodiment of the marine propeller pitch control system of the present invention;

Figure 2 is a transverse cross-section along the line II–II of Fig. 1;

Figure 3 is a fragmentary longitudinal cross-section illustrating a second embodiment of the marine propeller pitch control system of the present invention; and

Figure 4 is a similar view of a third embodiment of the pitch control system of the invention.

Referring firstly to Figs. 1 and 2, a first practical embodiment of the marine propeller pitch control system in accordance with the present invention comprises a variable pitch screw propeller 10 having a hub 11 and blades 12. A propeller shaft 13 connects the propeller 10 to a gear box and driving motor (not shown). The shaft 13 fits into a reception bore 14 at the inboard end of the propeller 10 and is held non-rotatably therein by a propeller hub key 15 and a shaft locking nut 16.

At the outboard end of the propeller 10 an actuator housing 17 having an end cap 18 is connected to the propeller hub 11 by a clamp ring 19. A piston 20 having a hollow piston rod 21 is disposed within the housing 17 and is sealed for longitudinal sliding movement therein by seals 22. A collar 23 around the piston rod 21 extends from the piston 20 and when the piston 20 moves to the right in Fig. 1 the end of said collar engages in a recess 24 in an annular abutment piece 25 positioned adjacent the outboard end of the propeller hub 11. Spring means in the form of coil springs 26 surround the piston rod 21 and 23 and bias the piston 20 away from the abutment piece 25. A piston stop 27 seated in the end cap 18 limits the movement of the piston 20 to the left in Fig. 1 by abutment of the end of the piston rod 21 against an annular flange 28 provided on said stop 27. The stop 27 is hollow and passageways in its end wall 29 and flange 28 ensure communication between the channel 30 in the piston rod 21 and the internal space 31 of the actuator housing 17. A hollow piston guide 32 extends between the piston rod 21 and the shaft 13, fitting internally into each, so that the channel 30 is continuous from the shaft 13 to the rod 21 and the stop 27. The piston rod 21, of course longitudinally slidable on the piston guide 32.

Centrally within the propeller hub 11, the piston rod 21 is supported by being threadedly engaged in a bore 34 in an annular yoke 33.

The pitch control mechanism mounted in the propeller hub 11 is of the conventional cam block and trunnion type and consists of the aforesaid yoke 33 carrying four pins 35 which respectively engage in cam slots 36 formed in four cam blocks 31 secured to respective trunnion shafts 38 of the blades 12. Thus longitudinal movement of the piston rod 21 causes the pins 35 to rotate the cam blocks 37 by their engagement in the slots 36 and hence to alter the pitch angle of the four blades 12.

The use of this pitch control system when fitted to a ship will readily be appreciated from the foregoing description. Pressure fluid, namely oil, is present in the channel 30. In the relaxed/release/unstressed condition, as illustrated, the springs 26 bias the piston 20 to abut the stop 27 at a first limiting position and the propeller blades 12 which are acted upon via the piston rod 21 and yoke 33, take up a fine-pitch angle, that is to say a small or low angle relative to a neutral position radial to the axis of the propeller 10. The blades 12 naturally tend to take up such position so the action of the springs 26 merely serves to hold them steady.

When it is desired to change the speed of the ship from high thrust/low speed towing condition with fine-pitch angle blades to a lower thrust/higher speed normal running condition, a pump mechanism (not shown) is actuated to pump more oil into the channel

30. Via the passageways in the stop 27, the oil flows into the space within the actuator housing 17 and the pressure thereof acts on the outboard side of the piston 20 to force same against the bias of the springs 26 towards a second limiting position whereat the collar 23 abuts the abutment piece 25. As the piston 20 and piston rod 21 move to the right in Fig. 1, the yoke 33 also moves and the pins 35 thereof act via cam slots 36 to swivel the blades 12 to progressively coarser pitch, that is to say to a larger angle relative to radial to the axis of the propeller 10. The maximum permitted angle is attained when the piston rod 21 abuts the abutment piece 25.

Once the pump is switched off, the oil pressure is released and under the action of the springs 26 the piston 20 returns to its former postion and the blades 12 return the fine-pitch angle setting.

Of course, if the pump or oil supply should fail, the piston 20 will remain or will become pressed against the stop 27 and the blades 12 will retain or take up a fine-pitch angle setting.

For fine tuning of the propeller 10, that is to say to adjust the exact blade angles of the limiting fine and coarse pitch settings, it is a relatively simple matter to release the clamp ring 19 and rotate the actuator housing 17. This will generally be done after trials and will be accomplished manually after raising the hull out of the water to expose the propeller(s). Rotation of the housing 17 screws the piston rod 21 into or out of the yoke 33 and thus increases or decreases the tension of the springs 26.

Figs. 3 and 4 shows two modifications of the propeller pitch control system of the invention, Fig. 3 being a "high-power" version suitable for a large ship and Fig. 4, a low-power version suitable for a smaller craft. In each case, for clarity, the same reference numerals have been used for parts corresponding to those in the embodiment of Figs. 1 and 2. The main difference between these modifications and the above described embodiment, besides dimensions, is that in Fig. 3 the spring means is in the form of stacks of disc springs 40 and in Fig. 4 a solid block of rubber 50 is used as spring means. These are equally as good as the coil springs 26 of the first embodiment and it should be appreciated that the spring means in any particular pitch control system in accordance with the invention may be selected from these three alternatives or may consist of any combination of these three types of spring means namely disc springs, coil springs or solid blocks of rubber or similar material.

The foregoing is, of course, illustrative and not limitative of the scope of the invention and variations are possible. For example, the pressure fluid may feasibly be air or water or any other fluid, although it will normally be oil as in the abovedescribed preferred embodiment.

CLAIMS

1. A marine propeller pitch control system comprising a screw propeller having a hub with variable pitch blades whose range of pitch angle variation extends between two predetermined limiting settings namely a fine-pitch angle and a coarse-pitch angle, a shaft connecting the propeller to a gear box and driving motor, and a channel extending through the shaft and into the propeller so that pressure fluid admitted through the channel acts on a piston disposed within the outboard end of the propeller, which piston is operatively coupled to a pitch control mechanism for effecting pitch angle adjustment of the blades, the piston being permanently acted on by spring means biassing the piston towards a first limiting position corresponding to a predetermined fine-pitch angle of the blade, means veing provided to selectively admit pressure fluid through the channel to force the piston to move against the biassing action of the spring means towards a second limiting position corresponding to a coarse-pitch angle of the blades.

2. A marine propeller pitch control system as claimed in claim 1 incorporating abutment means which serve to restrict the movement of the piston between the aforesaid first and second limiting positions.

3. A marine propeller pitch control system as claimed in claim 1 or 2 wherein the spring means consists of a stack of disc springs, or, alternatively a number of coil springs or resilient blocks of rubber or similar material.

4. A marine propeller pitch control system as claimed in claim 1, 2 or 3 wherein a portion of the channel is formed through am member which threadedly engages a propeller yoke so that fine tuning of the blade pitch settings can be easily effected by manual rotation of the outboard end portion of the propeller with respect to said yoke so as to increase or decrease the tension of the spring means.

5. A marine propeller pitch control system substantially as hereinbefore described with reference to and as illustrated in Figs. 1 and 2, or in Fig. 3 or in Fig. 4 of the accompanying drawings.

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